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Integrated Pest Management Guide

Southwestern Dwarf Mistletoe, *Arceuthobium vaginatum* subsp. *cryptopodum* (Engelm.) Gill, in Ponderosa Pine

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Introduction

Southwestern dwarf mistletoe (SWDM), Arceuthobium vaginatum subsp. cryptopodum, is the most damaging disease of southwestern ponderosa pine, Pinus ponderosa var. scopulorum Engelm., and occurs throughout the range of its host from northern Mexico through Arizona and New Mexico into Colorado and Utah (4). In Arizona and New Mexico, SWDM is found on more than one-third of the commercial forest acreage (possibly 2,500,000 acres) and is estimated to cause losses of over 150 million board feet annually (1). The disease causes mortality and growth reduction in infected trees; causes a decrease in the quantity, quality, and germination percentage of seeds produced; and lowers timber quality. Heavily infected trees are more susceptible to attacks by insects and other diseases and to environmental stresses such as drought. Infected trees may sustain a 30- to 60-percent reduction in growth when compared to noninfected trees (12). Dwarf mistletoe infects trees of all ages and is thus a problem in second growth and regeneration, as well as mature and overmature stands (3).

Research and experimental management has been carried out on the silvicultural control of SWDM since the early 1920's (7). The results of this work have been published and available for over 50 years; however, new approaches are being developed and techniques for control are constantly being refined. The primary objective of this guide is to provide land managers with information on the biology of dwarf mistletoe and to outline the range of management alternatives available for control. Although the management alternatives presented are primarily oriented towards control of SWDM, they also apply in general to any species of dwarf mistletoe on any host.

Biology of Southwestern Dwarf Mistletoe

Dwarf mistletoes are parasitic, seed-bearing plants that depend upon their hosts almost completely for water and nutrients (5). Although dwarf mistletoe shoots contain chlorophyll and manufacture some food, the parasite gets most of its nutrients through the endophytic system, a specialized rootlike structure that is in contact with the phloem and xylem of host trees. "Roots" consist of cortical strands that grow through phloem and bark, and secondary structures (sinkers) that become imbedded in wood as branches add annual growth (9).

Dwarf mistletoes spread by explosively released seeds; water pressure builds up inside fruits until the seeds are expelled to distances ranging from 17 to 40 feet, depending upon the height of plants in the tree. Seeds of SWDM are dispersed in late July and early August and infection takes place within a few months after dispersal; most infections take place through the bark on the needle-bearing portions of twigs. The first aerial shoots appear between 2 to 5 years after infection; this period of infection before shoots are visible is known as the latent period (9). Because some infections are not always visible, dwarf mistletoe control is a continuous process over the life of a stand. New infections that continue to appear must be removed in subsequent stand entries. Spread of dwarf mistletoe in ponderosa pine stands is a function of stand age, density, and site index, and averages 1 to 2 feet a year. Spread is most efficient and rapid from an infected overstory to an understory and slowest through even-aged stands (6).

Symptoms and Signs of Infection

Usually the sequence of disease expression is:

Branch swelling (fig. 1). As the endophytic (root) system of the dwarf mistletoe continues to grow within a branch, it stimulates the xylem and phloem tissues to abnormal growth. The result is a conspicuous swelling of the branch at the point of infection. Along with this swelling, there may or may not be:

Plants (fig. 2). Aerial portions of both male and female plants consist of leafless, yellow to green or brownish-green, segmented, perennial shoots that average 4 to 6 inches (10 to 15 cm) long and one-eighth to one-quarter inch (3 to 6 mm) in diameter. Remains of these shoots can often be seen imbedded in the bark of infected trees and are known as basal cups. Sometimes plants and basal cups are found on the main trunk of the tree; these infections are known as:

Bole infections (fig. 3). A resin-soaked canker often forms at the site of a bole infection. These infections have little or no effect on the vigor or growth of pole-sized or larger trees; however, they seriously damage or kill seedlings and saplings. Much of the stress and nutrient drain on infected trees are caused by:

Witches' brooms (fig. 4). As the endophytic system of the parasite continues to develop, the branch habit of the host tree becomes distorted and witches' brooms, dense clusters of branches and foliage, are formed. Broomed branches are usually not pruned naturally by the tree and represent a nutrient sink that seriously reduces the vigor of the host. Trees pruned of large witches' brooms often show dramatic increases in vigor and life span.

Fig. 1. Swollen branch and dwarf mistletoe.

Fig. 2. Dwarf mistletoe plants.

Fig. 3. Bole infection and canker.

Fig. 4. Witches' broom.

Measuring Infection Intensity

A 6-class dwarf mistletoe rating system, developed by Hawksworth (4), is used to quantify the intensity of dwarf mistletoe infection in individual trees. It can also be used to rate infected stands, giving rise to an average dwarf mistletoe rating. To use the system, the live crown is divided into thirds and each third is assigned a rating of 0, 1, or 2: 0--no visible infections; 1--one-half or less of the branches in the third are infected; 2--more than one-half of the branches in the third are infected. The ratings for each third are added to determine the infection class of the tree. There are six possible ratings for infected trees (1-6), plus one for noninfected trees (0).

Infection classes 1, 2, and 3 usually result in little or no impact on growth of pole- and sawtimber-size trees. Those in classes 4, 5, and 6 are declining in growth rate and vigor, and are poor-risk trees. Seedlings and saplings may be seriously affected even when in classes 1, 2, and 3.

Generally, infection level increases about one mistletoe rating class every 10 years. Mortality rates are much higher for trees in infection classes 4, 5, and 6, than for classes 1, 2, and 3, or noninfected trees.

Instructions

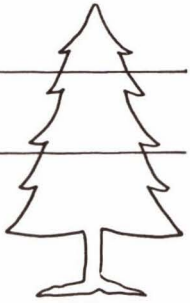
Step 1: Divide live crown into thirds.

Step 2: Rate each third separately. Each third should be given a rating of either 0, 1, or 2 as described below.

- 0 - No visible infections
- 1 - Light infection (½ or less of total number of branches in the third infected).
- 2 - Heavy infection (more than ½ of total number of branches in the third infected).

Step 3: Add ratings of thirds to obtain rating for total tree.

Example



If this third is lightly infected, its rating is 1.

If this third is lightly infected, its rating is 1.

If this third is heavily infected, its rating is 2.

AND THE TREE IN THIS EXAMPLE WILL RECEIVE A RATING OF 4 (Class 4 tree).

Management of Southwestern Dwarf Mistletoe

Dwarf mistletoes, like the trees they infect, are an integral part of the natural forest ecosystem. The balanced relationship between host and parasite has evolved over a long period of time and there is no danger that SWDM will eliminate ponderosa pine in the Southwest. Neither can dwarf mistletoe be eradicated; the best that can be expected is to reduce the losses due to dwarf mistletoe to acceptable levels. Ideally, integrated pest management depends on a variety of measures--chemical, biological, and silvicultural--to control a pest. Luckily, several aspects of the biology of SWDM make it easy to control silviculturally: (1) It spreads relatively slowly in a tree and through a stand; (2) since it is an obligate parasite, it dies when the host tree dies; and (3) it is host specific; tree species other than ponderosa pine are not infected. At this time, there are no chemical or biological controls available and none are expected in the near future (11).

EVALUATION

In order to be most effective, silvicultural control measures for dwarf mistletoe should be incorporated in the management planning process at the earliest stages.

Stands infested with dwarf mistletoe should receive high priority when management activities such as thinning and harvesting are being scheduled. Simulated yield models such as RMYLD (2) are valuable tools to help select appropriate control strategies. RMYLD can be used to predict the yields on a per acre basis of even-aged and two-storied stands of ponderosa pine in the Southwest, and can also simulate the effects of various intensities of dwarf mistletoe infestation on the growth of trees in the stand. Resource managers can use this model to simulate various intensities of growing stock levels in thinning, to quantify losses for economic analysis, to compare the effects of deferred versus immediate entries into an infested area, and to determine if an infested stand will return acceptable yields over a rotation. Stand parameters, including the extent and intensity of dwarf mistletoe infestations, can be obtained from Regional compartment examinations or from specialized detection surveys.

PREVENTION

Prevention is the most efficient and economical method of reducing dwarf mistletoe impact. To prevent an infestation from starting, all infected trees should either be removed or killed in each regeneration area, including burns, before the new stand can become infected.

The following three steps should be followed in all dwarf mistletoe-infested areas being regenerated:

1. During the seed-tree cut, before regeneration has become established, harvest all merchantable infected trees. Unmerchantable or unsalable infected trees should be felled as part of the site preparation.

2. During the final removal cut, when regeneration has become established, remove or kill all infected trees.

3. In all subsequent entries into the new stand, including the first thinning, remove or kill all infected trees.

Spread of dwarf mistletoe from surrounding infested stands is likely to be a problem on the edges of regeneration areas. In the planning process, efforts should be made to minimize exposure of the new stand by locating the boundaries of the regeneration area in uninfected or nonhost type stands, or along natural breaks in type or terrain which would prevent reinfection of the area. Trees which do become infected should be removed during intermediate cuts.

SUPPRESSION

Losses due to dwarf mistletoe in established stands can be controlled without eradicating the disease. Using the simulated yield model RMYLD as a guide, stands should be thinned to growing stock levels (GSL) that will maximize fiber production while meeting other management concerns. An otherwise healthy even-aged stand of ponderosa pine on a good site can often outgrow the effects of a dwarf mistletoe infestation. The key to controlling dwarf mistletoe with intermediate cuts is to remove enough trees so that remaining crop trees will respond to the thinning; in stands with crop trees of pole and sawtimber size, remove infected trees regardless of spacing and diameter limits in order to reach the prescribed stocking level. Heavily infected stands that will not provide acceptable yields or meet other objectives should be regenerated. In stands with crop trees of

seedling/sapling size (average d.b.h. 5 inches), infected pole- and sawtimber-sized trees should be removed prior to or within 5 years after the thinning. If they cannot, the thinning should be delayed until the infected overstory can be removed. During thinnings, all infected trees should be removed regardless of spacing and diameter limits to reach adequate stocking levels. Trees in infection classes 1 and 2 may be left if they are otherwise desirable as crop trees. Pruning infected branches is not recommended unless it can be done at no additional cost while thinning.

CONTROL IN RECREATION AREAS

Control measures used in recreation areas can usually be applied more intensively than those in forest stands because of the relatively high value of the trees (8). Options for control are:

1. Pruning witches' brooms. Pruning large witches' brooms can dramatically increase the vigor and life span of heavily infested trees. This method should only be used on large, valuable trees that would retain at least a 30-percent live crown after pruning.

2. Sanitation and thinning. The first step in this option is the treatment of any infected overstory. Heavily infected and excess trees in both overstory and understory are removed. The objective of sanitation and thinning is to maximize growth of lightly infected and healthy trees.

3. Pruning of infected branches. This option is used when lightly infected trees, pole size or smaller, can be sanitized and there is little chance they will be re-infected. Two whorls of branches above the highest visibly infected branch should also be removed to eliminate latent infections; again, after pruning, the trees should have at least a 30-percent live crown.

4. Underplanting with a tree species resistant or immune to the particular dwarf mistletoe being controlled.

Any or all of the above options may be combined and applied in order to accomplish management objectives.

In all prevention and suppression activities, provisions must be made to time activities, or to dispose of or otherwise treat slash, cull logs, and other debris to reduce the potential for Ips beetle outbreaks(10).

Assistance in dwarf mistletoe management can be obtained from the following organizations:

Federal and Indian Lands -- USDA Forest Service
Forest Pest Management
517 Gold Avenue, SW
Albuquerque, NM 87102
Telephone: (505) 766-2440
FTS 474-2440

State and private lands -- Arizona State Land Department
1624 West Adams
Phoenix, AZ 85007
Telephone: (602) 255-4627

New Mexico Department of
Agriculture
P.O. Box 6
Albuquerque, NM 87102

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